Panel 2 - Pipeline System Integrity and Operational Impacts of California Gas Quality Rules

Natural Gas Quality Standards Workshop

February 17-18, 2005

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Key System Integrity and Operational Components of Rule 30

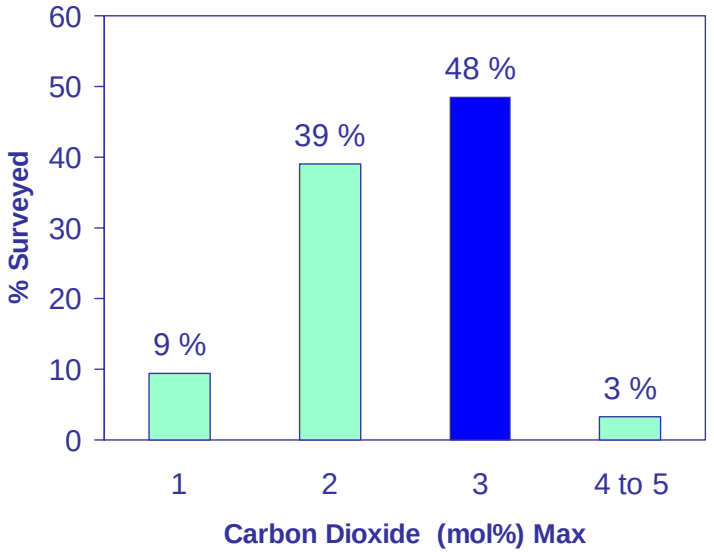
• Carbon Dioxide	3.0 % Maximum
• Oxygen	0.2 % Maximum
• H_2S	0.25 gr
• Total Sulfur	0.75 gr
• Water Vapor	7 lb/MMscf
• Hydrocarbon Dew point	45°F at 400 psig or 20°F at 800+ psig
• Delivery Temperature	50-105°F
• Total Inerts	4% Maximum

- Free of Dust, Gum, Objectionable, and Solid Matter
- Free of Liquids

Carbon Dioxide 3% Maximum

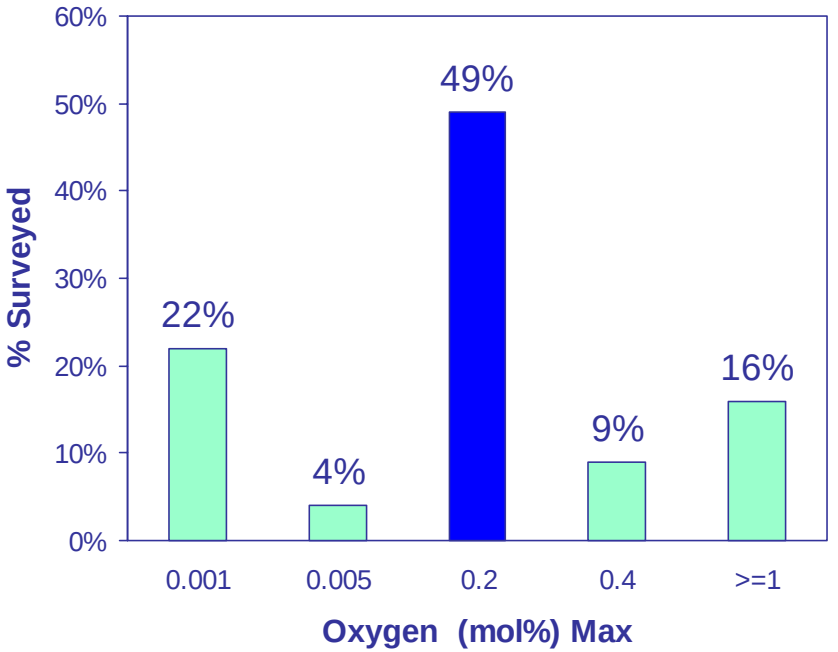
- Impacts Pipeline Integrity
- CO_2 dissolved in water forms carbonic acid that will corrode pipelines
- SCG limit consistent w/others
- Some specify or recommend lower CO_2 limits

- Extracted pipe samples have shown evidence of corrosion
- $FeCO_3$ a by product of CO_2 corrosion found at a number of locations



Oxygen 0.2% Maximum

- Increases pitting corrosion
- Drastically increases corrosion rate of CO_2 & H_2S
- SCG limit is consistent w/others

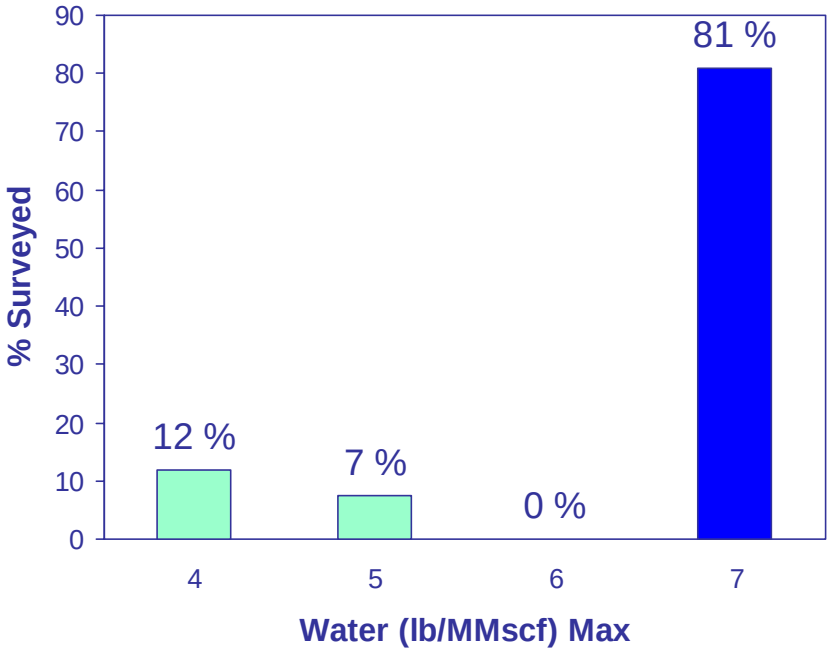


Sulfur Standards

- Rule 30 H_2S (0.25 gr/Ccf H_2S) and Total Sulfur (0.75 gr/Ccf S)
- CPUC GO 58A Limits H_2S (0.25 gr/Ccf H_2S) and Total Sulfur (5.0 gr/Ccf S)
- CPUC requires notification if above limit
- SCAQMD 431.1 and other APCD Limits Total Sulfur (16 ppm H_2S)
- $H_2S + H_2O$ dissolves to form a weak acid that dissolves iron creating iron sulfide
- Oxidizable to elemental sulfur may lead to regulator problems
- Excessive leak complaints

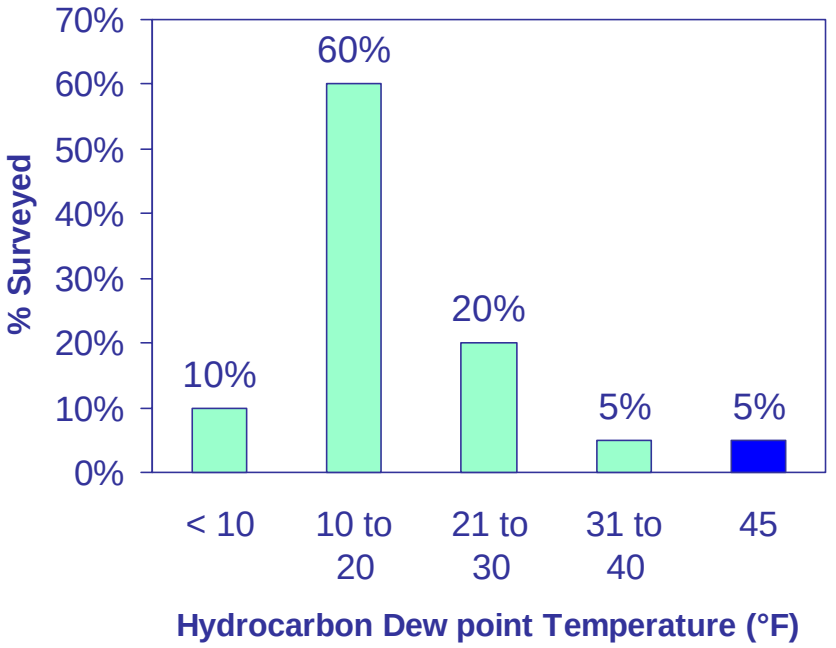
Water Vapor 7 lb/MMscf

- Pitting or localized corrosion prevails when combined with CO_2,O_2, H_2S
- Condensation & accumulation in low spots
- Hydrates and Icing
- Causes meter and regulation problems



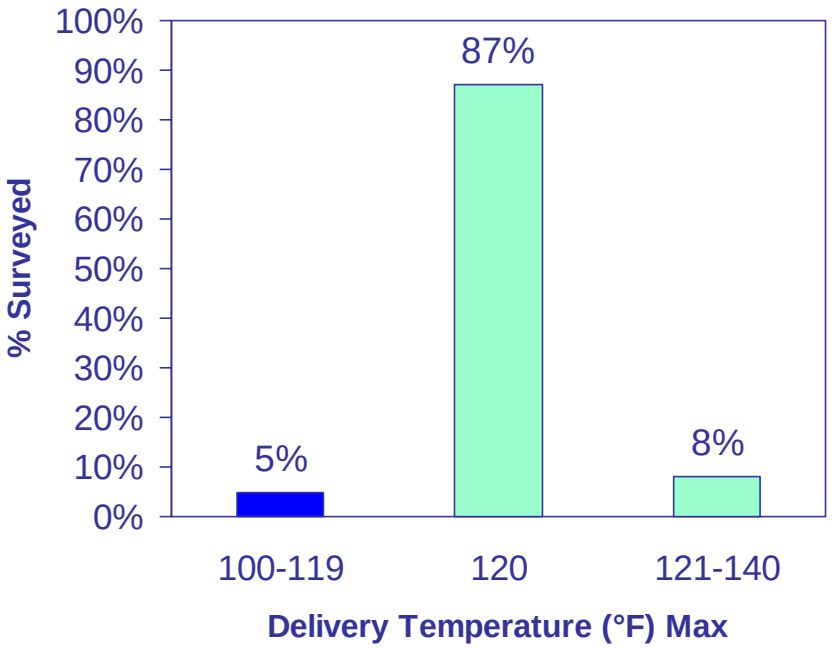
Hydrocarbon Dew point 45°F at 400 psig or 20°F at 800+ psig

- Condense and collect in low points causing restrictions
- Condensates are breeding ground for anaerobic acid forming bacteria which can cause bacterial corrosion
- Customer complaints, damage equipment and disposal issues



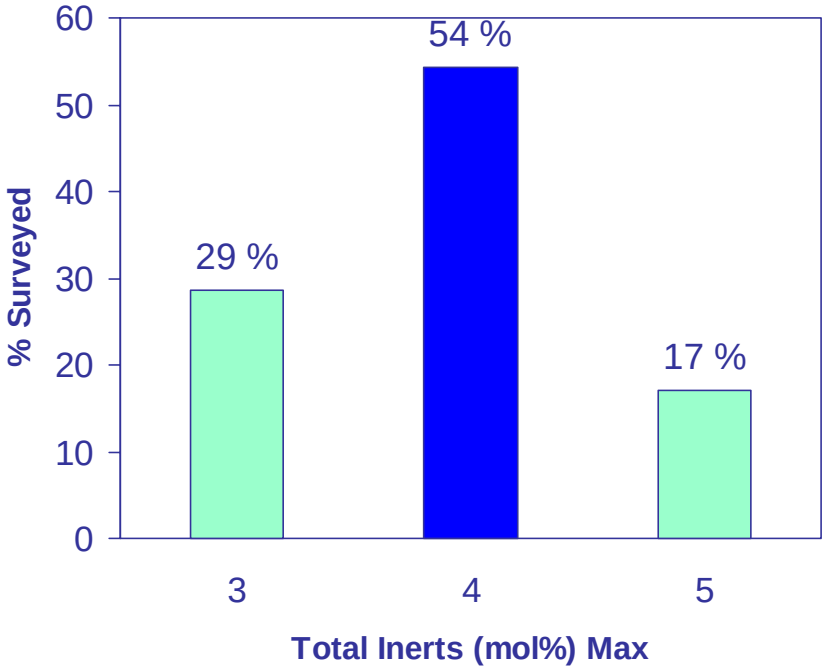
Delivery Temperature 50-105°F

- Assures pipeline integrity
- Increasing temperature increases corrosion rate
- Damages pipeline coating
- Min. T prevents condensation



Total Inerts 4% Maximum

- Controls BTU and non methane HC concentration
- Leads to customer utilization problems
- Nitrogen affects heat treatable alloys, glass manufacturing (annealing)
- CARB NGV Fuel Spec - 4.5% Maximum



Free of Dust, Gum, Objectionable, and Solid Matter

- Plug customer's burners
- Extinguish Pilot lights
- Interfere with process equipment
- Manufacturer spec on particulates and metals

Free of Liquids

- If water not from condensate can carry TDS and bacteria.
- Provides an opportunity for MIC to occur.
- TDS, salts (Chloride) increase conductivity thus contribute to increasing the corrosion rate.
- Impact pH.